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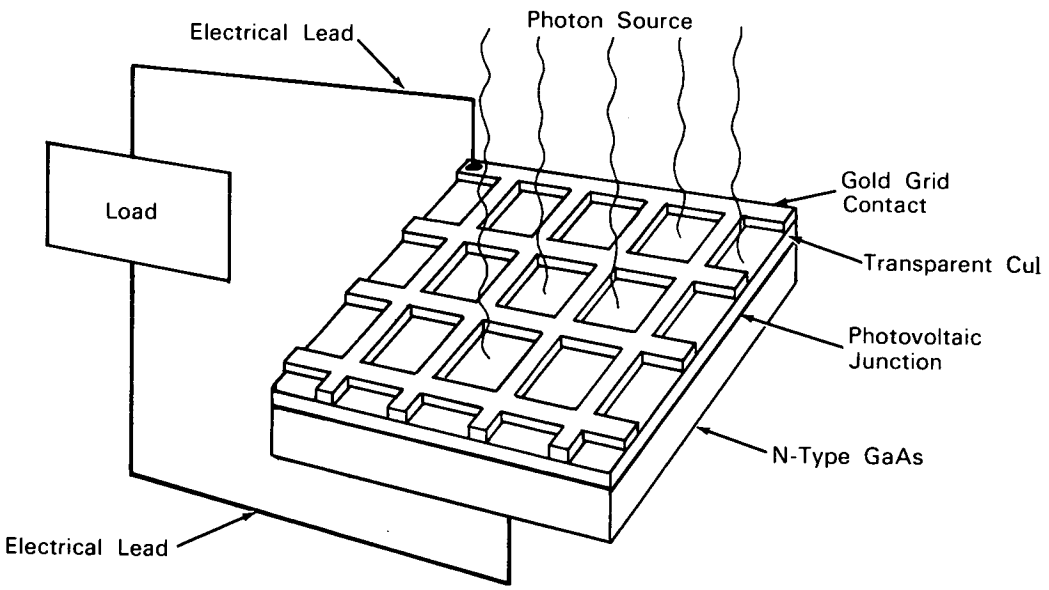
NASA TECH BRIEF

This NASA Tech Brief is issued by the Technology Utilization Division to acquaint industry with the technical content of an innovation derived from the NASA space program.

New Method Used to Fabricate Gallium Arsenide Photovoltaic Device



The problem: Gallium arsenide (GaAs) photocells, or solar cells, as currently made, require that zinc be diffused onto n-type GaAs with close control of time and temperature followed by an exacting etching process which will bring the free surface of the cell close to the junction. The junction-to-surface distance is critical and is of the order one-half micron. Heterojunction cells (i.e., containing a photovoltaic junction formed by two semiconductors having different forbidden band gaps) have less critical thickness requirements. However, they also require high-temperature processing and encounter serious difficulties in preparation.

The solution: A strong inversion layer is produced very near a surface of GaAs by the influence of a chemical phase in contact with the surface. The chemical phase used, copper iodide (CuI), when placed on n-type GaAs, produces a p-type surface layer and a photovoltaic junction.

How it's done: The CuI layer is preferably formed by direct vapor deposition of a 3- to 4-micron thickness onto GaAs. Alternate methods include evaporation or electroplating copper onto GaAs and subsequently exposing the copper surface to iodine vapor.

GaAs of the n-type with a carrier concentration in the range 10^{16} to $10^{17}/cm^3$ is cut into sheets or wafers with 111 surfaces. The A side is used for the CuI deposition. The GaAs surface is prepared by etching with $5H_2SO_4$, $1H_2O_2$, $1H_2O$ until the work-damaged layer is removed and the surface is smooth. After water washing and drying, it is etched in 1 percent bromine in methyl alcohol for 20 seconds with

(continued overleaf)

some agitation, water washed and dried; washed in HF for 30 seconds, and again water washed and dried. If the technique of electroplating copper onto GaAs is used, the GaAs is not dried as the final step of the etching procedure but is transferred wet to the copper-plating solution.

The CuI layer is then formed by direct evaporation onto GaAs. After exposing the unit to iodine vapor at 70°C for 2 minutes, gold is evaporated onto the CuI to form an ohmic contact, which may be grid shaped. After a second 2-minute exposure to iodine vapor at 70°C, the completed unit is allowed to cure in dry air for 2 days.

Photocells made by this technique have given open-circuit voltages of 0.82 volt and short-circuit currents of 20 milliamperes under illumination by a focused microscope light.

Notes:

1. Industrial application of this innovation would include energy conversion devices (e.g., solar cells), photo-detector devices, direction sensing photocells, and pattern recognition matrices.
2. Photocells of special or irregular shape may easily be formed by the use of vacuum deposition for forming the CuI.
3. For further information about this innovation inquiries may be directed to:
   Technology Utilization Officer
   Western Operations Office
   150 Pico Boulevard
   Santa Monica, California 90406
   Reference: B64-10019

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA and inquiries about obtaining royalty-free rights for its commercial use may be made to NASA Headquarters, Washington, D.C. 20546.

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